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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
B65H 23/32, D04H 1/74

A1

(11) International Publication Number: **WO 98/56702**

(43) International Publication Date: 17 December 1998 (17.12.98)

(21) International Application Number: PCT/EP98/03335

(22) International Filing Date: 2 June 1998 (02.06.98)

(30) Priority Data:
97304008.2 10 June 1997 (10.06.97) EP
(34) Countries for which the regional or international application was filed: AT et al.

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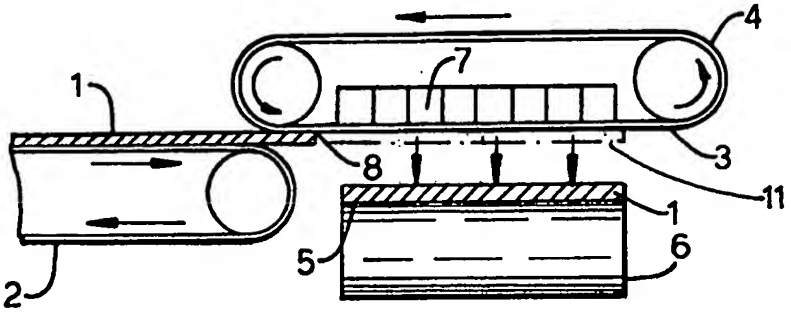
(81) Designated States: AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: PROCESS AND APPARATUS FOR TRANSPORTING A WEB

(57) Abstract

A travelling web of fibers (2) is turned through 10 to 170° by being held by suction up against a travelling carrier (4) as it approaches a transverse fold line (9), the suction is released at the fold line (9) and the web is folded downwardly at the fold line and transported away from the carrier on a conveyor (6).



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Process and Apparatus for Transporting a Web

This invention relates to processes and apparatus by which a web can be turned from a first substantially horizontal direction of travel to a second substantially horizontal direction of travel. Typically this second direction is approximately perpendicular to the first.

The conventional way of achieving this at present comprises feeding the web in the first direction up to an edge which extends diagonally across the direction of travel of the web and so defines a transverse fold position, folding the web downwardly and underneath this edge into the desired second direction and transporting the web away from the transverse fold position by a collecting conveyor which is travelling in the second direction.

The angular change in direction is twice the angle the edge makes to the first direction. Thus if the edge is at 45° to the first direction of travel, the second direction of travel is at 90° to the first.

Generally the web is fed towards the edge by a conveyor which feeds the web in the first direction on to fixed elements such as slats or on to rollers or other moving elements which define the diagonal, transverse edge. The edge is usually not a continuous smooth surface, but is instead a stepwise edge. If the elements which define the edge are designed to move with the web as it travels around the edge, they necessarily have a rather bulky configuration, due to the engineering necessarily associated with them. If the elements which define the edge are fixed, there is a risk that they will damage the web as it travels around them.

When the apparatus is intended for transporting a typical light but bulky mineral web, it is necessary to have a considerable vertical drop between the first and second directions, typically about 50cm or more, to give room for the apparatus necessary for creating the turn.

The web is often travelling at relatively high speed as it approaches the transverse fold position and it can be difficult to encourage it to fold accurately around the edge without, on the one hand, undergoing damage or, on the other hand, necessitating complex apparatus to encourage it to fold at the desired position.

Because of the difficulties of constructing the apparatus, it tends to be inflexible and so it is difficult to provide an apparatus which can be adjusted to give different changes in the direction of travel.

According to the invention a process for changing the direction of travel of a web from a first substantially horizontal direction to a second substantially horizontal direction which is at an angle of 10 to 170° to the first direction comprises

feeding the web in the first direction to a transverse fold position which extends across the web at an angle of 5 to 85° to the first direction,

folding the web downwardly into the second direction at the transverse fold position and

transporting the web away from the fold position by a collecting conveyor which is travelling in the second direction,

and in this process the transverse fold position extends across the underside of a permeable carrier which travels in the first direction at substantially the same speed as the web,

the web is held by suction up against the carrier as the web approaches the fold position,

the suction is released at the fold position and the web is thereby allowed to fall downwardly, and

the web is folded into the second direction and is transported in the second direction away from the fold position by the collecting conveyor.

One advantage of the invention is that the web is supported (by suction) close to the fold position while it is being carried right up to the transverse fold position,

and so there is no risk of damaging the web as it moves around a fixed edge.

Because the support is from above (by suction) there is no need to provide bulky apparatus between the levels of the web feed and the collecting conveyor to serve as the edge which defines the fold position. Accordingly it is possible to fold the web back on itself through a much shallower drop than is necessary with conventional apparatus, for instance 20cm compared to 50cm (for conventional mineral fibre production apparatus).

Because the transverse fold position is defined by the position at which suction is released, it is easily possible to move this position, for instance to adjust its angle relative to the first direction, merely by providing movable baffles or other means of providing suction selectively through the carrier.

The web can be fed to the underside of the carrier by any suitable means, including by being held by suction up against the underside of a conveyor as the conveyor travels towards the carrier. Generally, however, the web is fed on the upper surface of a conveyor which is travelling in the first direction to a feed position at the underside of the permeable carrier. Generally the web, after being folded down and around the transverse fold position, is collected on the upper side of the collecting conveyor, which is travelling in the second direction.

The first and second directions are substantially horizontal, in that they convey the web longitudinally more than vertically. If desired, either or both may be inclined to the horizontal, e.g., at an angle up to 20°.

In order to improve the transfer of the web from the underside of the carrier on to the upper surface of the collecting conveyor it is sometimes useful to apply suction down through the collecting conveyor. This can be applied over the entire surface of the collecting conveyor in the general region where the web moves down towards it or the suction can be applied only through a relatively limited

area, for instance a zone having approximately the same configuration as, and located immediately beneath, the transverse fold position.

In order to promote release of the web from the carrier, it is sometimes desirable to blow air down through the carrier at or substantially immediately after the transverse fold position. Thus the web is held by suction as the web and carrier move to the transverse fold position and is then blown downwardly off the carrier.

Preferably the entire turning and folding of the web is achieved by the application of suction (up through the carrier and optionally down through the collector), optionally by blowing air (down through the carrier), and by the transport of the web away from the transverse fold position. Thus it is not necessary, and it is undesirable, to provide any bulky mechanical elements between the levels of the web feed and the collecting conveyor, either on the inside or on the outside of the path of travel of the web as the web approaches the transverse fold position and folds around it and is carried away on the collecting conveyor. If desired, there can be one or more simple guides, but usually there are no mechanical elements between these levels. Thus the apparatus is simplified compared to known apparatus, the drop between the carrier and the collector can be small, and the risk of damaging the web by engagement with fixed elements is eliminated.

The transverse fold position generally has the configuration of a smooth line, and generally a straight line, compared to the stepwise line which defines it in conventional apparatus. Generally it is provided by a wall or other transverse baffle which defines the edge of the area through which suction is applied selectively (areawise) up through the carrier. Thus the carrier typically travels beneath a suction duct by which suction is applied up through the carrier and this duct extends up to a transverse baffle which defines the end of the area through which suction is applied and thus defines the

transverse fold position. This baffle may be, for instance, a vertical wall mounted within a suction box, so as to define the end of the box. It may instead be a horizontal plate or other shield which blocks the suction to prevent it acting on the web, for instance being located between the carrier and the suction duct. The shield defines a suction-free strip or area through the carrier to provide the transverse fold position.

When the baffle is at 45° to the first direction then the second direction is substantially perpendicular to the first. An advantage of the invention is that the angle of the baffle with respect to the first direction is adjustable between 5 and 85° so that the second direction can be at any angle between 10° (when the baffle is at 5° to the first direction) up to 170° (when the baffle is at 85° to the first direction). Usually the baffle is at an angle of 30 to 60° (often about 45°) and the second direction is at an angle of 60 to 120° (often about 90°) to the first direction.

It is also possible to arrange the suction duct, for instance the baffle or other means for defining the transverse fold position, so that the carrier can be used selectively to turn the web either onto a collecting conveyor travelling in a second direction extending away from one side of the first direction or onto a collecting conveyor travelling in a second direction extending away from the other side of the first direction. Thus the web may selectively be fed on to the carrier with the suction box arranged to turn the web either through an angle of 10 to 170°, generally around 90°, to the first direction or to turn the web through an angle of 190 to 350°, often around 270°, to the first direction.

The process, and the novel apparatus, are each primarily designed for turning a web of mineral fibres, preferably being an air laid web of mineral fibres. The mineral fibres are often referred to as man-made vitreous fibres (MMVF). Preferably the web is unbonded.

The invention is of particular value when the web is a material made by fiberising a vitreous melt by use of at least one centrifugal fiberising rotor and thereby forming a cloud of fibres, carrying the cloud of fibres by an airstream from adjacent the rotor or rotors to a permeable collector, and collecting the fibres as a web on the collector.

The fibres may be formed using a spinning cup which rotates about a substantially vertical axis. Melt is fed into the cup and thrown out through perforations in the wall of the cup as fibres. The fibres may be attenuated by an annular air stream (often hot) and are collected downwardly onto a collector that moves beneath the cup.

Preferably, however, the fibres are formed using one or more fiberising rotors which rotate about a substantially horizontal axis and the cloud of fibres is carried substantially horizontally onto a permeable collector by which the fibres are carried as a web away from the fiberising rotor or rotors. For instance the fibres may be formed using a cascade spinner comprising a first rotor onto which melt is poured and off which it is thrown centrifugally and at least one subsequent rotor onto which the melt is thrown from the preceding rotor and off which fibres are thrown, and an airstream emerges from around the individual rotors and/or around the cascade spinner and carries the resultant fibres to a moving permeable collector on which they are collected as a web. The collector is usually upwardly inclined.

Preferably some or all of the suction air which is used in the invention (to hold the web up against the carrier as it approaches the fold line) is collected and is used as part of the airstream which carries the cloud of fibres towards the collector, for instance which emerges around the rotors. As a result of ducting the suction air from the carrier to the fiberising rotors, the air is reused and it is not vented direct to the atmosphere, with the associated need to provide filters to clean the air

before venting. A similar recycling system is also described in PCT/EP97/00965.

The invention is of particular value when it is used for turning a web which is to be subsequently cross lapped, or which has been cross lapped, either using a conventional cross lapping apparatus or, preferably, using apparatus as described in PCT/EP97/00965.

The invention can also be utilised for simultaneously turning and laminating the web. Thus two or more webs may be fed in side-by-side relationship to the underside of the carrier, and a transverse fold position is provided for each web individually, the individual fold positions being arranged one behind the other in the second direction. Thus, for instance, if an initial broad web is split longitudinally into two webs of substantially equal width as it approaches the carrier or on the carrier, it is possible to turn these into a laminate of two layers travelling in the second direction.

The invention includes the novel process and the novel apparatus for carrying out the process on MMVF webs.

Although the process and apparatus are designed primarily for turning MMVF webs, corresponding process and apparatus can be designed for other air laid webs or sheet materials. Thus they can be designed for a web which is a paper sheet, plastic film or other sheet having structural integrity, but generally it is an air-laid non-woven web. The web can be made of organic textile fibres such as cotton, cellulose, rayon, polyamide, acrylic or polyester, and thus can be, for instance, a web of the type used for the manufacture of clothing, interlinings or other organic textiles.

The invention is illustrated in the accompanying drawings in which

Figure 1 is a plan view from above of suitable apparatus in use

Figure 2 is a view in the direction II-II in Figure 1

Figure 3 is a view from underneath the carrier shown in Figure 1, all other parts of the apparatus being omitted

Figures 4 to 10 are diagrammatic illustrations of various ways of turning, and optionally sub-dividing and recombining, the web material by utilising the invention, for instance using apparatus similar to that illustrated in Figures 1 to 3.

Referring to Figures 1 to 3, a web 1 is fed in a first direction (shown by arrow FD) on the upper surface of a feed conveyor 2 to a feed position 8 on the underside 3 of a carrier 4. The web is transported away from this carrier in a second direction (shown by arrow SD) on the upper surface 5 of a collecting conveyor 6.

The carrier 4 is a perforated mesh or other permeable band which travels over a series of suction boxes 7 which together define a suction duct which extends from the feed position 8 where the web first contacts the carrier to a transverse fold position 9. This transverse fold position 9 can be defined by a plate 10 which extends between the carrier 4 and the suction boxes 7 and thereby blanks off part of the ducts.

As a result of the termination of suction as the web reaches the line 9, the web falls downwardly (as shown at 11 in Figure 2) along the transverse fold line 9 and is carried away on the collection conveyor 6.

Figure 4 is a flow diagram indicating the direction of movement of the web when the apparatus is arranged as shown in Figures 1 to 3. Thus the web extends across the width of the carrier from the side L (left) to the side right (R) along the first direction (FD). The fold line 9 created by the shield or other baffle 10 extends at an angle of 45° across FD and as the web drops down from the permeable carrier and around the fold line onto the collecting conveyor it therefore turns through 90° and is conveyed away from the carrier in the second direction SD, perpendicular to the first direction FD.

The lengthwise position of the fold line 9 along the first direction with respect to the feed position 8 can be fixed or can be adjustable. Figure 5 shows the options when it is adjustable. If the fold line is relatively close to the feed position 8, it is at the position marked 9A and the folded web leaves the apparatus along SD1. However when the fold position is moved longitudinally away from the feed position 8, for instance by moving the plate 10, the fold position is then at the point marked 9B and the web leaves the apparatus along SD2. Thus it is possible to move the web laterally on the collecting conveyor 6 merely by longitudinal displacement of the plate 10 or other means for creating the fold line.

The web can be slit lengthwise along line or lines 13 as it approaches the fold line, either by being slit before it reaches the carrier 4 or while it is on the carrier 4. The lengthwise slitting can slit the web into three or more strips, each usually of substantially the same width, which can be folded independently. For simplicity, the system wherein the web is merely slit into two equal strips is illustrated in Figure 6. In this, the slit is shown by the dashed line 13 and extends through the central position of the web, marked M, and so divides the web into one part 1A which extends between the edge L and the position M and a second part 1B which extends between M and R, the right-hand edge. There are two separate fold lines, 9C associated with web 1A and 9D associated with web 1B. Each of the narrower webs is turned independently at its associated fold line and the webs are then laid one on top of the other on the conveyor and are carried away as a laminate of the two webs. By dividing the web into narrower strips, or by combining the double layered web obtained in the system of Figure 6 with multi-layered webs obtained from one or more similar systems, it is thus possible to build up a plurality of layers on the conveyor and carried away as a laminate in direction SD.

A particular advantage of systems such as shown in Figure 6 is that the laminated web which is collected may be more uniform in thickness or other properties than the initial web which is fed towards the feed line 8. Thus if, as often occurs, the web is thinner and/or of lower density at the edges L and R than at the centre M, the web turned in the system of Figure 4 will maintain this variability in thickness or density across the width, but the layered web formed in the system of Figure 6 will have more uniform thickness and density. This is because the thicker or denser edge M of the strip 1A will be laid over the thinner or lighter edge R of strip 1B, and the denser or thicker edge M of strip 1B will be laid over the lighter or thinner edge L of the strip 1A.

Figure 7 demonstrates that it is easily possible for a single turning apparatus of the invention to turn the web either in one direction (shown as SD3) or in a very different, and generally directly opposite, direction shown as SD4.

Thus in the apparatus of Figure 7 there are two conveyors 6 (not shown), one leading to the right (as viewed from direction FD) and one leading to the left. By selective application of suction through the carrier it is possible to create the fold line either at the position marked 9E or at the position marked 9F. When the fold line is at the position marked 9E, the web will be turned through 90° to the right, in direction SD4. When the fold line is in position 9F, the web will be turned through 90° to the left (or 270° to the right) and will be carried away leftwards in direction SD3.

In Figure 8, the principles of the systems shown in Figures 6 and 7 are combined. Thus the web is slit along the centre line 13 (or along two or more lines) as in Figure 6 to create strips 1A and 1B. Each of these strips is led towards its associated fold line, shown as 9G for strip 1A and 9H for strip 1B. Strip 1A is led away from the conveyor leftwards in direction SD3 and strip 1B is led

away from the conveyor rightwards in direction SD4. These separate strips may be used in the same way as, for instance, the single web from Figure 4 or they may be laid one upon the other so as to form a laminate. For instance the strips can be led away in directions SD3 and SD4 and then turned through 180°, for instance by passing around a roller, and led back to one another and then collected as a laminate on a collector. As a result it is easily possible to arrange that, for instance, edge M of strip 1A coincides with, and is under or over, edge M of strip 1B, while edge L of strip 1A coincides with edge R of strip 1B. In some instances this can be desirable, for instance when the initial web is thicker at one edge and tapers gradually across its width, since the resultant web will then be of more uniform thickness across its width.

The angular orientation of the fold line 9 with respect to the feed direction FD can be fixed but is usually adjustable. It can be adjusted by, for instance, merely pivoting the plate 10 in Figure 3, optionally combined with longitudinal movement as in Figure 5. For instance in Figure 9 there is shown the possibility of having the fold line in positions 9K or 9J. In position 9K, it extends at about 60° across the feed direction FD and the collecting conveyor 6 is positioned at an angle of about 120° to FD so as to carry the turned web away along the second direction SD5 at about 120° to FD. In another position, the fold line is at 9J at an angle of about 30° to FD, and the collecting conveyor is arranged to carry the turned web away along SD6 at an angle of about 60° to FD.

The system of Figure 9 can be achieved by moving the plate 10 or by any other convenient arrangement for moving a transverse baffle which defines the end of the area through which suction is applied and thus defines the transverse fold position.

Instead of physically moving a shield or other baffle member, the same effect can be achieved by any other convenient arrangement of the means for applying suction.

For instance there can be two independently controllable suction ducts. Usually the more convenient way of achieving this is to be able to operate different areas of suction boxes independent of one another so as to allow for changes in the area-wise distribution of suction through the area. For instance, referring to Figure 9, the suction boxes can be arranged so that either suction is applied in the area extending from line 8 to line 9K or in the area extending from line 8 to line 9J.

Another way of varying the area-wise distribution of suction, and thus moving the line 9 is by arranging the suction duct to extend up to line 9 and moving the suction ducts as required so as to move the position of line 9. For instance in the diagrammatic illustration shown in Figure 10, the suction box is pivoted about .p. When the angle α is 45°, the second direction will be as shown in Figure 4. However when the suction duct is pivoted so that the angle α is less than or greater than 45°, the orientation of the second direction will likewise be shifted.

As mentioned above, the invention can be used in combination with a conventional crosslapping system or with a crosslapping system as described in PCT/EP97/00965. For instance it can be used to turn the web through approximately 90° (as is conventional), or it can be used to make smaller adjustments in the direction of travel of the web. For instance it is explained in PCT/EP97/00965 that it can be desirable to adjust the angle of feed of the web to the crosslapper so that the angle of fed is exactly parallel to the desired transverse orientation of laps in the crosslapped product. Thus, instead of feeding the web towards the crosslapper at 90° to the collection direction (the web can be fed at an angle slightly different from 90° such that the web fed is exactly parallel to all the laps (when they are all deposited as separate parallel pieces as described with reference to Figure 7, or parallel to half

the laps when they are deposited as a continuous web, as described with reference to Figure 6 of PCT/EP97/00965.

By the invention, it is easily possible to adjust the approach angle of the web to the crosslapper by any of the systems described above for adjusting the orientation and position of the fold line 9. For instance the suction duct can be pivoted, as in Figure 10, so that the second direction from the apparatus shown in Figure 10 of this application is at the desired angle to the direction of collection of the crosslapped product. In particular, the combination of the turning device of this invention and the crosslapping device of PCT/EP97/00965 means that it is extremely easy to obtain accurate and predetermined orientation of the crosslaps merely by selecting independently or in combination the orientation of the suction in the crosslapping device and the orientation of the suction in the turning device. For instance the suction boxes in the two devices can be pivoted either in synchronisation or independently or in response to each other so as to obtain the desired optimum crosslapping configuration.

CLAIMS

1. A process for changing the direction of travel of a web from a first substantially horizontal direction to a second substantially horizontal direction which is at an angle of 10 to 170° to the first direction by feeding the web in the first direction to a transverse fold position which extends across the web at an angle of 5 to 85° to the first direction, folding the web downwardly into the second direction at the transverse fold position, and transporting the web away from the transverse fold position by a collecting conveyor which is travelling in the second direction, characterised in that the transverse fold position extends across the underside of a permeable carrier which travels in the first direction at substantially the same speed as the web, the web is held by suction up against the carrier as the web approaches the fold position, the suction is released at the fold position and the web is thereby allowed to fall downwardly, and the web is folded into the second direction and is transported in the second direction away from the fold position by the collecting conveyor.

2. A process according to claim 1 comprising feeding the web on a feed conveyor travelling in the first direction to the underside of the permeable carrier and collecting the web on the upper side of the collecting conveyor travelling in the second direction.

3. A process according to claim 2 in which suction is applied downwardly through the collecting conveyor to pull the web on to the collecting conveyor.

4. A process according to any preceding claim in which air is blown down through the permeable carrier at the folding position in order to promote release of the web from the carrier at the folding position.

5. A process according to any preceding claim in which the web is folded at the fold position substantially only by suction which is applied selectively area-wise up through the carrier, and optionally suction through the

conveyor, and optionally blowing through the carrier, and by transport on the collecting conveyor.

6. A process according to any preceding claim in which the permeable carrier travels beneath a suction duct for applying suction up through the carrier and this suction duct extends up to a transverse baffle which defines the transverse fold position.

7. A process according to claim 6 in which the location of the fold position is adjustable with respect to its lengthwise position in the first direction and/or with respect to its angular orientation with respect to the first direction.

8. A process according to any preceding claim in which the second direction is at an angle of 60 to 120° to the first direction and the transverse fold position is at an angle of 30 to 60°, preferably 45°, to the first direction.

9. A process according to any preceding claim in which two or more webs in side-by-side relationship are fed to the underside of the carrier and a transverse fold position is provided for each web individually, and the transverse fold positions for the webs are arranged one behind the other in the second direction whereby the webs are turned and laminated into a single web.

10. A process according to any preceding claim in which the web is an air laid web of MMV fibres.

11. A process according to claim 10 comprising forming the web by fiberising a vitreous melt by use of at least one centrifugal fiberising rotor and thereby forming a cloud of fibres, carrying the cloud of fibres by an airstream from adjacent the rotor or rotors to a permeable collector, and collecting the fibres as the web on the collector, and in which suction air is ducted from the carrier into the airstream.

12. Web transporting apparatus comprising a permeable carrier mounted for travel in a first direction from a feed position to a transverse fold position which extends at an angle of 5 to 85° to the first direction, a feed conveyor

mounted for travel in the first direction and for feeding a web to the underside of the permeable carrier at the feed position, a collecting conveyor mounted for travel in the second direction at 10 to 170° to the first direction for receiving web which falls downwardly from the fold position, and means for applying suction up through the carrier from the feed position up to the fold position whereby web is held to the carrier as it travels from the feed position to the fold position and is released at the fold position.

13. Apparatus according to claim 12 in which the means for applying suction comprise a suction duct which extends to a transverse baffle which defines the transverse fold position.

14. Apparatus according to claim 13 in which the location of the fold position is moveable lengthwise in the first direction or angularly with respect to the first direction.

Fig.1.

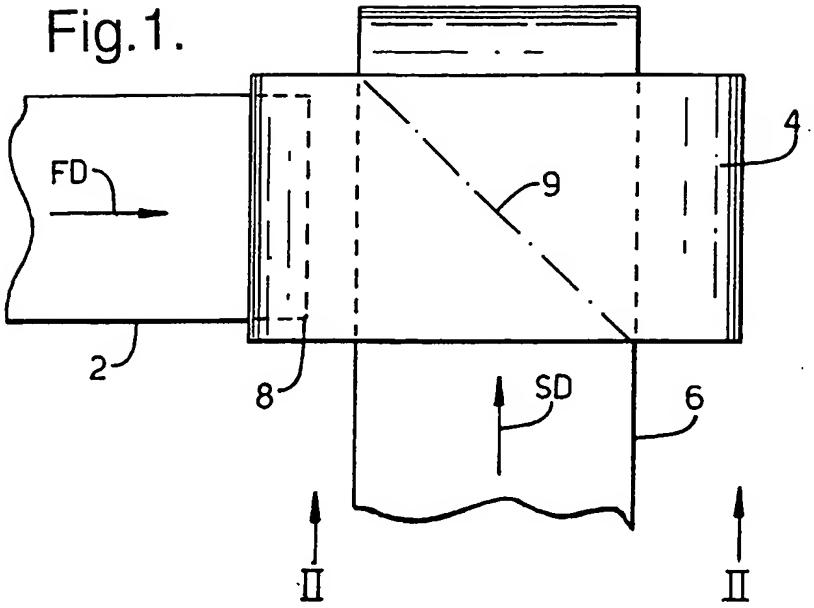


Fig.2.

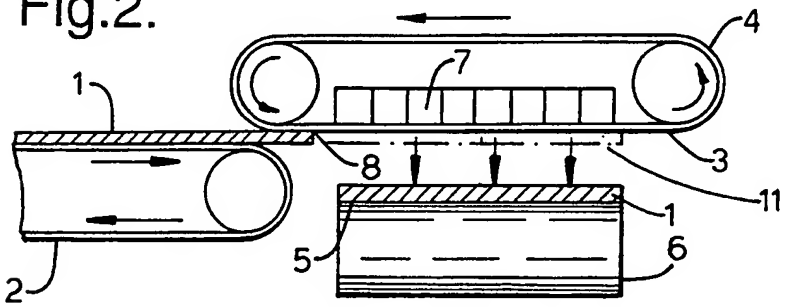


Fig.3.

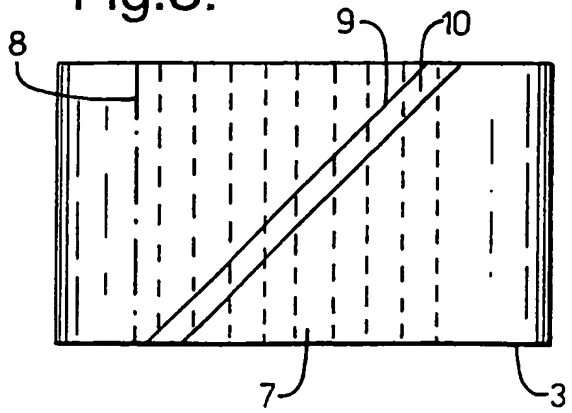


Fig.4.

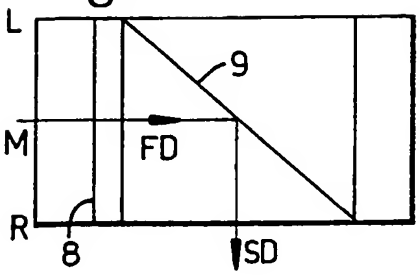


Fig.7.

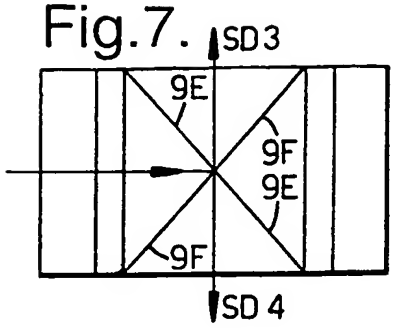


Fig.5.

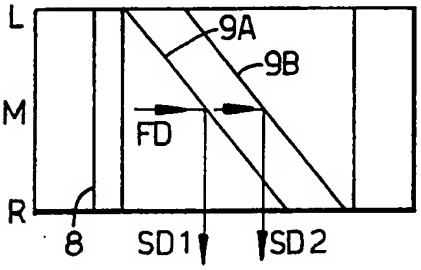


Fig.8.

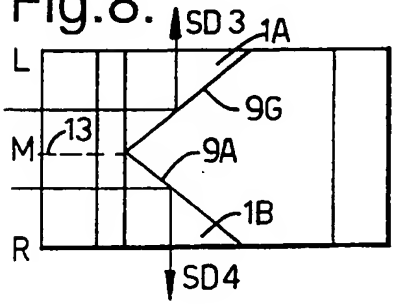


Fig.6.

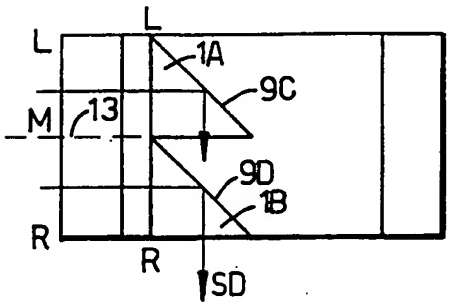


Fig.9.

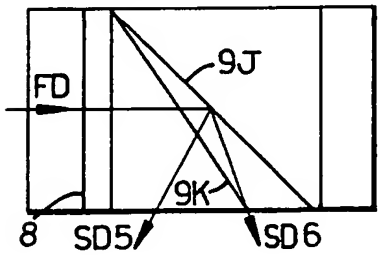
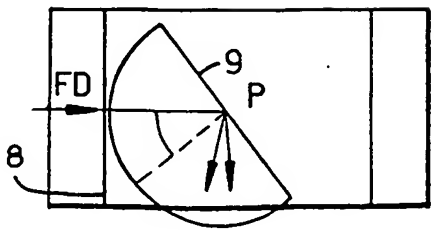


Fig.10.



INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 98/03335

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B65H23/32 D04H1/74

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B65H D04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,A	WO 97 32069 A (ROCKWOOL INT ;MOGENSEN LASSE (DK)) 4 September 1997 cited in the application see figures 8,9	1-14
A	US 4 687 125 A (HASHIMOTO KAZUYOSHI ET AL) 18 August 1987 see the whole document	1-14
A	US 5 316 199 A (HANSEN ROBERT E ET AL) 31 May 1994 see the whole document	1-14

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
10 November 1998	20/11/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Barathe, R

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 98/03335

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9732069 A	04-09-1997	AU 1878397 A	16-09-1997
US 4687125 A	18-08-1987	NONE	
US 5316199 A	31-05-1994	JP 6210819 A	02-08-1994